RABiTS Buffering using Combustion Chemical Vapor Deposition

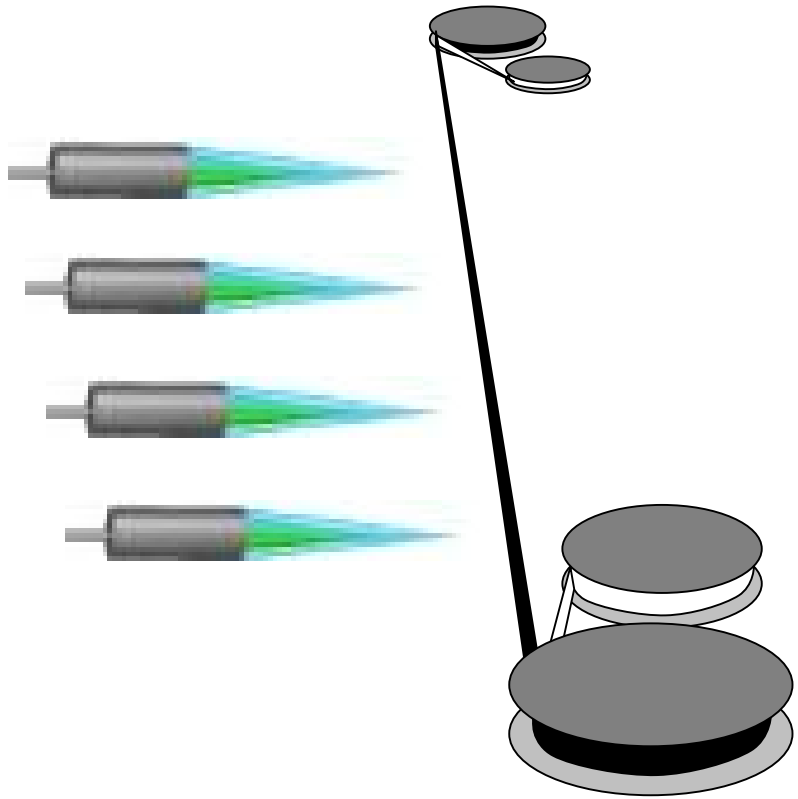
Todd Polley, Shara Shoup, Marvis White, Steve Krebs, Natalie Darnell
MicroCoating Technologies, Inc.

2003 Wire Development Workshop
January 21-22, 2003

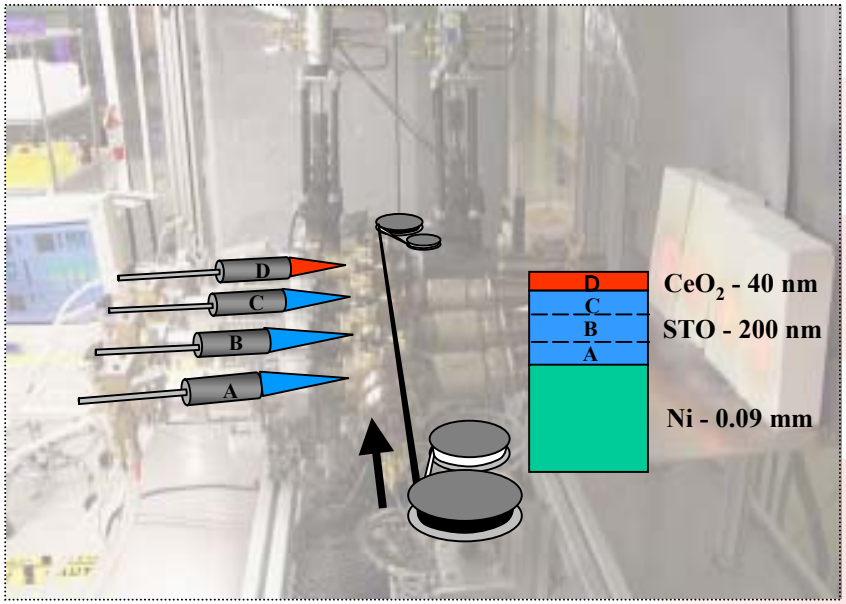
CCVD RABiTS Buffers

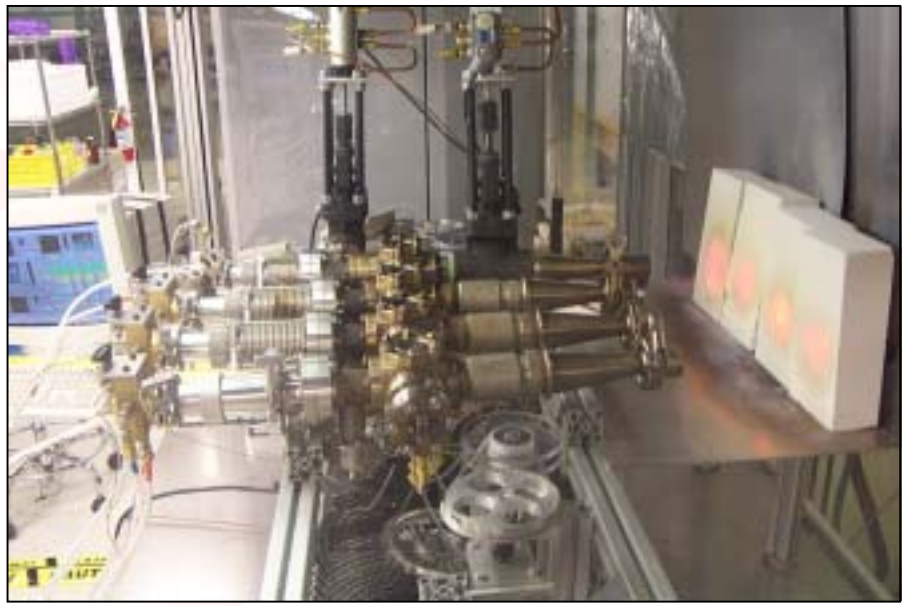
- **CCVD Technology:**
  - Atmospheric pressure flame based deposition of epitaxial buffers on reel-to-reel biaxially textured Ni or Ni-W tape.

- **CCVD Advantages:**
  - Multi-layering flexibility
  - Coating stoichiometry control and flexibility
  - Non-vacuum, long length process
  - Lower capital and material costs
  - Non-hazardous, environmentally friendly



Buffer Deposition System – Architecture Versatility



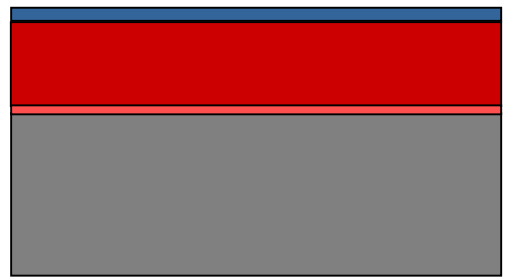


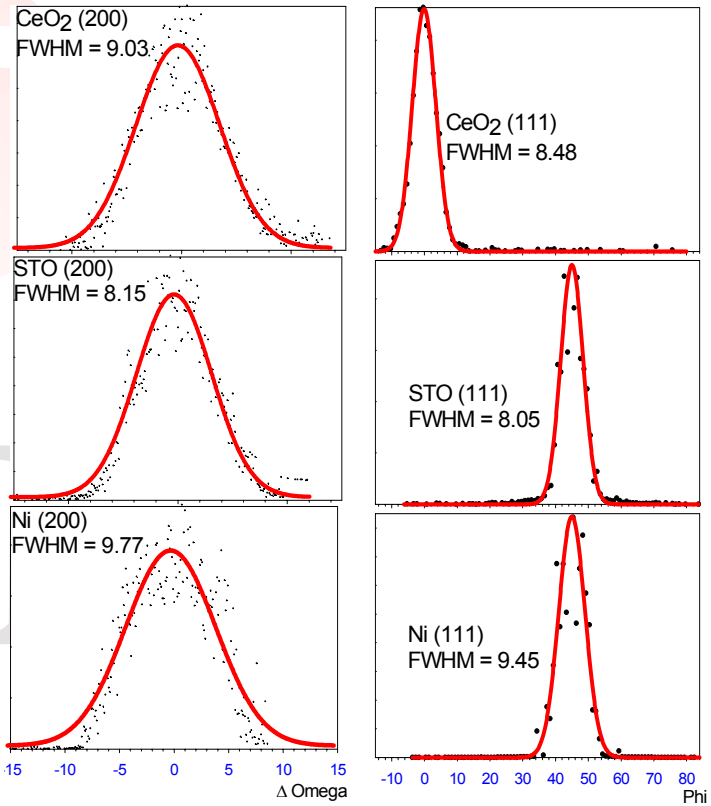
STO/Ni **CEO/STO/Ni** **$X_4/X_3/X_2/X_1$/Ni**

Replace "X" with BST, CeO_2, Gd_2O_3, LAO, LMO, LZO, Y_2O_3, YSZ or multiples of each for additional buffer architectures enabled by the CCVD technology

Overview of CCVD Buffer Coatings on Ni

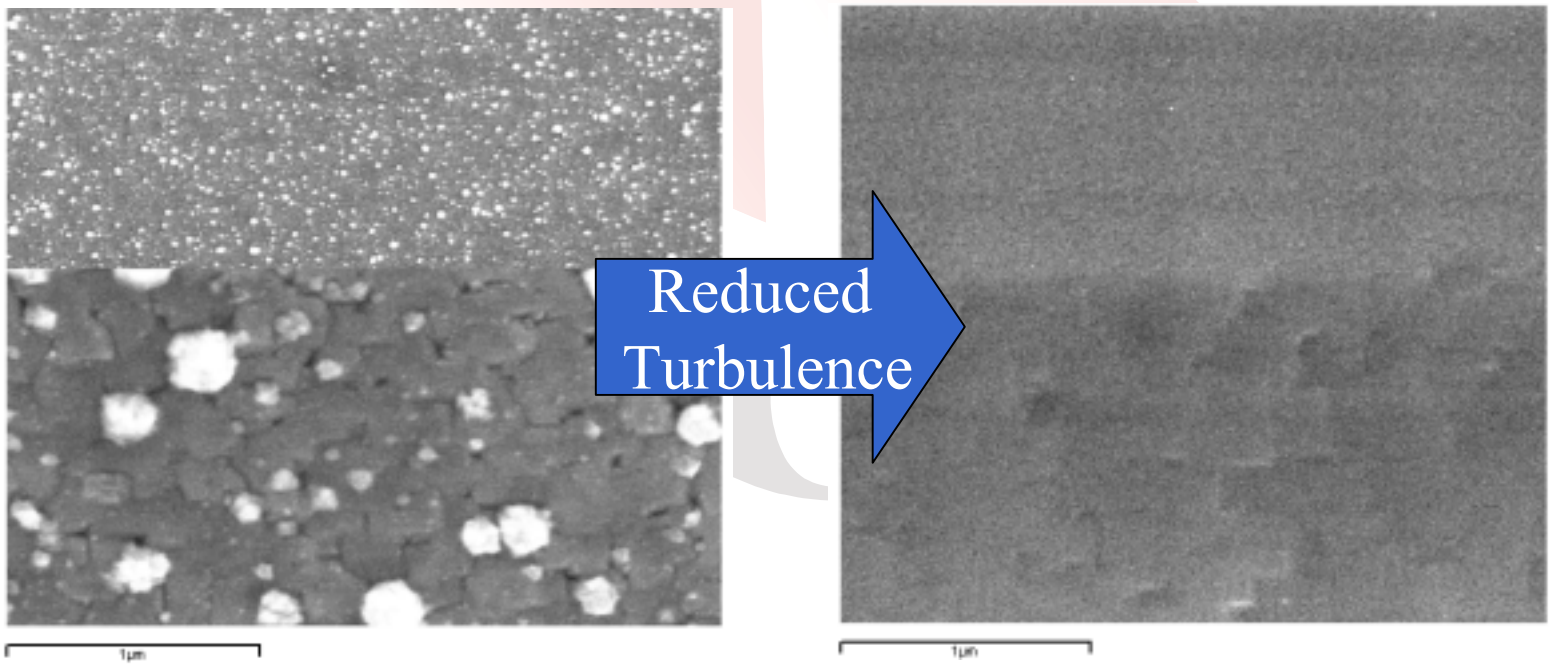
- **Standard architecture**
  - 10-50 nm CeO_2 cap/200 nm STO/BST seed
- **Epitaxy**
  - Epitaxial BST, STO, and CeO_2 deposited directly on Ni
  - 0% in-plane misorientation
  - Less than 2% out-of-plane misorientation
  - Phi and omega FWHM ≤ Ni
  - Uniform over meter+ lengths
- **Roughness**
  - Average of 18-20 nm (equivalent to Ni)
- **Diffusion Barrier**
  - Ni does not penetrate buffer (XPS depth profiles)
- **Electrical Characterization**
  - J_C of 1.12 MA/cm^2 demonstrated for PLD YBCO (ORNL) on CCVD RABiTS





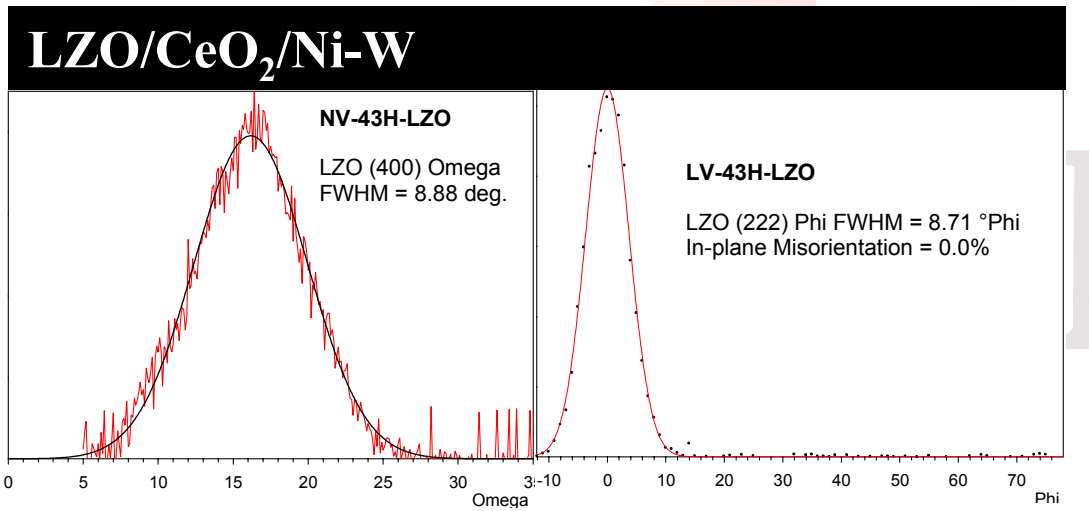
Recent CCVD Buffer Improvements

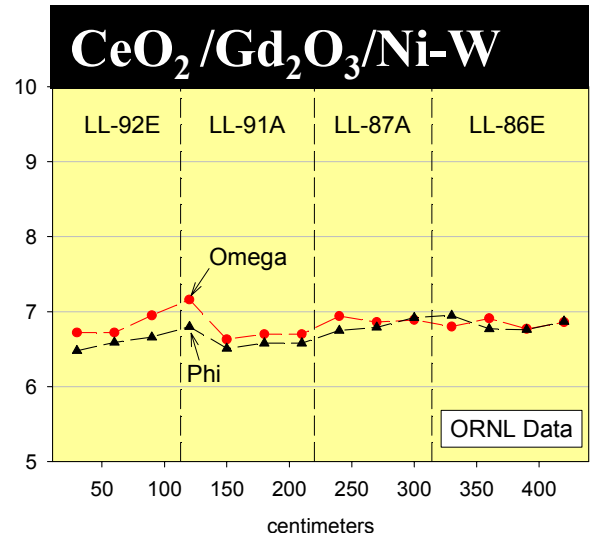
- **Microstructure and Epitaxy Improvements**
  - Reduction of gas turbulence near deposition region has reduced particle formation
    - Smoother gas flow geometries
    - Lower gas flow rates
  - Smooth, dense STO microstructure
  - Reduced out-of-plane misorientation
  - Potential increase in subsequently deposited YBCO's current carrying capability



Overview of CCVD Buffer Coatings on Ni-W

- **Several architectures show excellent epitaxy**
  - CeO_2 and Gd_2O_3 directly on Ni-W
  - LZO/CeO_2/Ni-W
  - CeO_2 /Gd_2O_3/Ni-W
  - Epitaxy uniformity along meter+ lengths
  - No appreciable difference in epitaxy obtained using OST and ORNL Ni-W
- **Electrical Characterization**
  - A limited number of samples have been qualified with PLD YBCO
  - Minimal J_c has been demonstrated





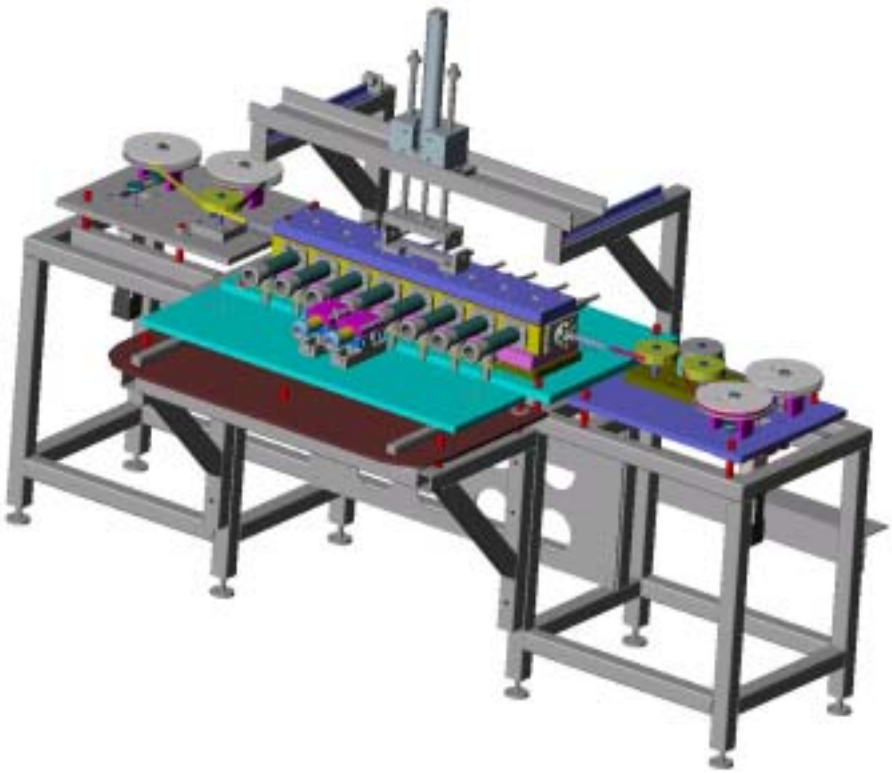
CCVD Buffer Goals for FY 2003

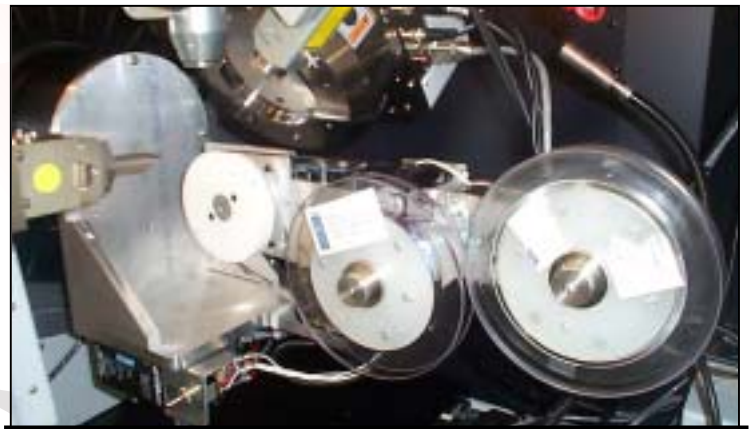
- **Scale to 25+ meter lengths of high-quality CCVD RABiTS**
  - Constructing an eight nozzle system
- **Enable critical currents of 100 amps for meter lengths (end-to-end)**
- **Optimize buffer architectures and properties**
  - Both on Ni and Ni-W
  - For a variety of YBCO deposition techniques, including CCVD
- **Continue to offer lengths of CCVD RABiTS for sale**
  - MCT began selling CCVD RABiTS in mid-2002
  - MCT has sold buffered tape to 2 U.S. and 2 international customers
  - Price sheet available with prices based on R&D quantities
  - MCT is currently scaling to double throughput

Next Generation of CCVD Deposition System

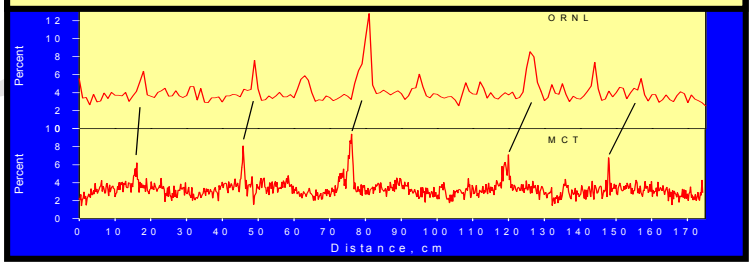
- **MCT's Scaled 8-nozzle System**
  - Double throughput
  - Incorporate design improvements
  - To be completed by the end of February 2003

- **Integrate In-line Diagnostics**
  - Continuous XRD monitoring
  - Indicates changes in texture
  - Tested in reel-to-reel mode



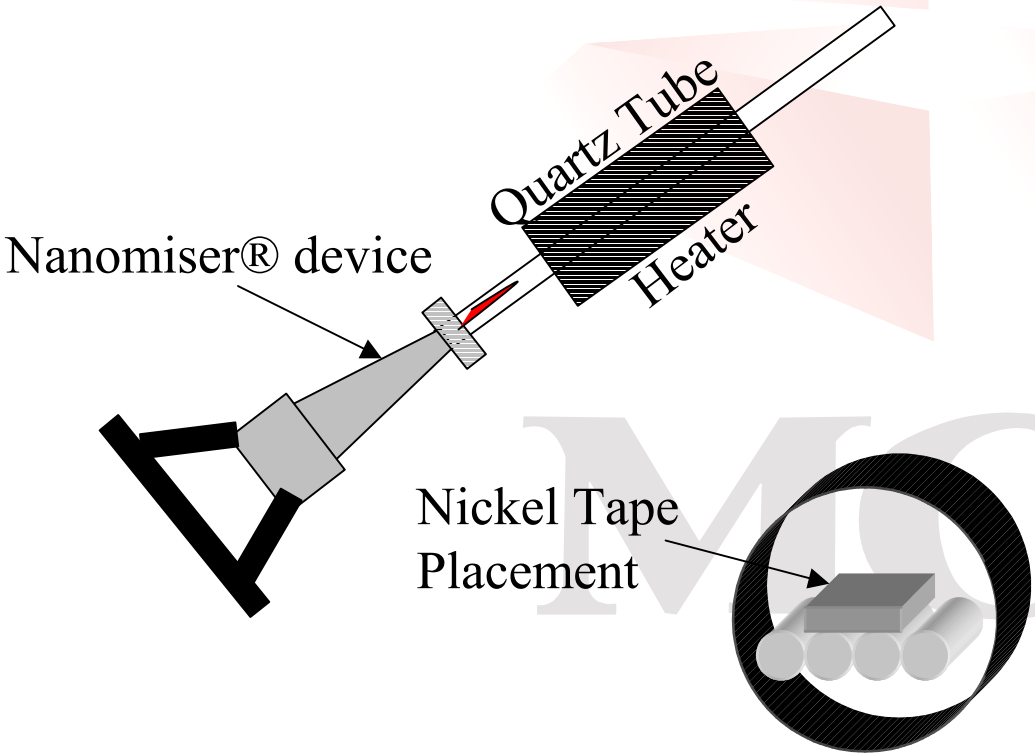


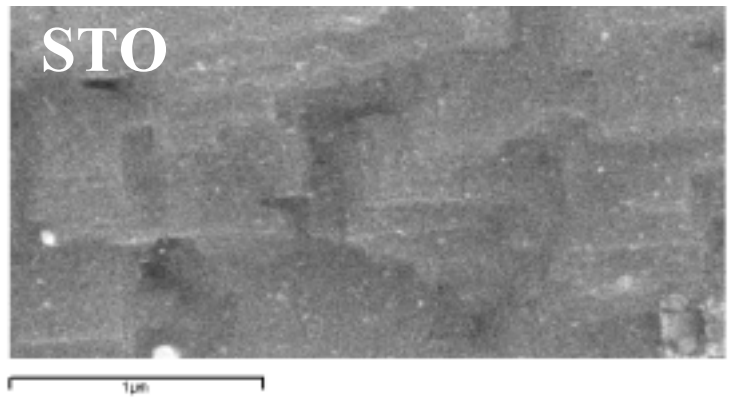
STO on Ni out of-plane % misorientation

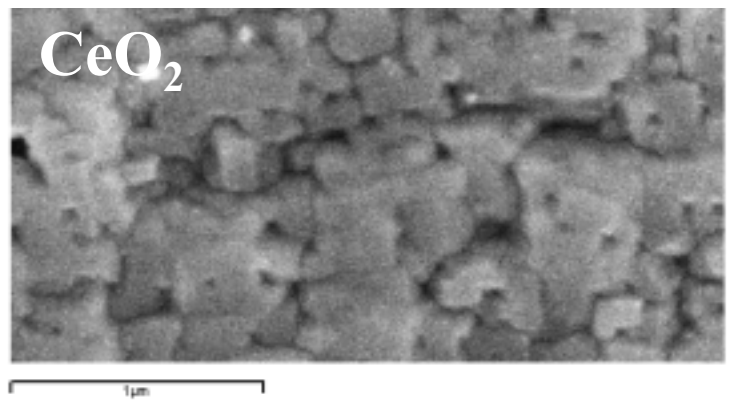


Next Generation of CCVD Deposition System

- **New Deposition Geometry**
  - Increased rate and efficiency
  - 10x increase in rate
  - Active control of deposition temperature
  - Requires further optimization of materials properties
  - Requires integration with tape motion







Collaboration

- **MicroCoating Technologies**
  - Optimization and scaling of RABiTS buffer deposition
  - Optimization of YBCO depositions
- **Oxford Superconducting Technology**
  - Optimization of Ni and Ni-W tapes
  - Supplied Ni and Ni-W tapes for buffer development
- **ORNL**
  - MCT and ORNL have exchanged buffer layers
  - ORNL has provided MCT with Ni-W
  - ORNL has deposited YBCO on CCVD RABiTS
  - MCT has used the Accelerated Coated Conductor Initiative facility for reel-to-reel XRD and laser scatterometry
  - MCT has purchased a commercial license for RABiTS
- **LANL**
  - LANL has deposited PLD YBCO on CCVD RABiTS
- **BNL**
  - BNL has deposited BaF_2 YBCO on CCVD RABiTS